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ARO-22817.3-MS-S DAAG29-85-C-0027

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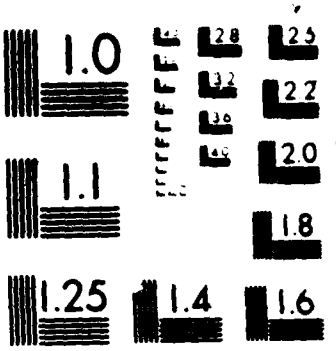

Contract No. DAAG29-85-C-0027

Interim Technical Report - April-May 1986

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARO 22817.3-MS-S	2. GOVT ACCESSION NO N/A	3. RECIPIENT'S CATALOG NUMBER N/A
4. TITLE (and Subtitle) PLASMA JOINING OF METAL MATRIX COMPOSITES		5. TYPE OF REPORT & PERIOD Interim Technical April/May 1986 6. PERFORMING ORG. REPORT NUMBER N.A.
7. AUTHOR(s) G.H. Reynolds and L. Yang		8. CONTRACT OR GRANT NUMBER(s) DAAG29-85-C-0027
9. PERFORMING ORGANIZATION NAME AND ADDRESS MSNW, Inc. P.O. Box 865 San Marcos, CA 92069		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Research Office Post Office Box 12211 Research Triangle Park, NC 27709		12. REPORT DATE November 1986 13. NUMBER OF PAGES 10
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

NA

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Composite materials, joining, plasma processing, thermochemistry.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Microchemical characterization of the effects of low-pressure transferred arc plasma processing on precomposited 1100 Al - 30 wt.% SiC_p and Al - 5 wt.% Ti - 30 wt.% SiC_p powders is described.

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ABSTRACT

Microchemical characterization of the effects of low-pressure transferred arc plasma processing on precomposited 1100 Al - 30 wt.% SiC_p and Al - 5 wt.% Ti - 30 wt.% SiC_p powders is described.

EXPERIMENTAL RESULTS

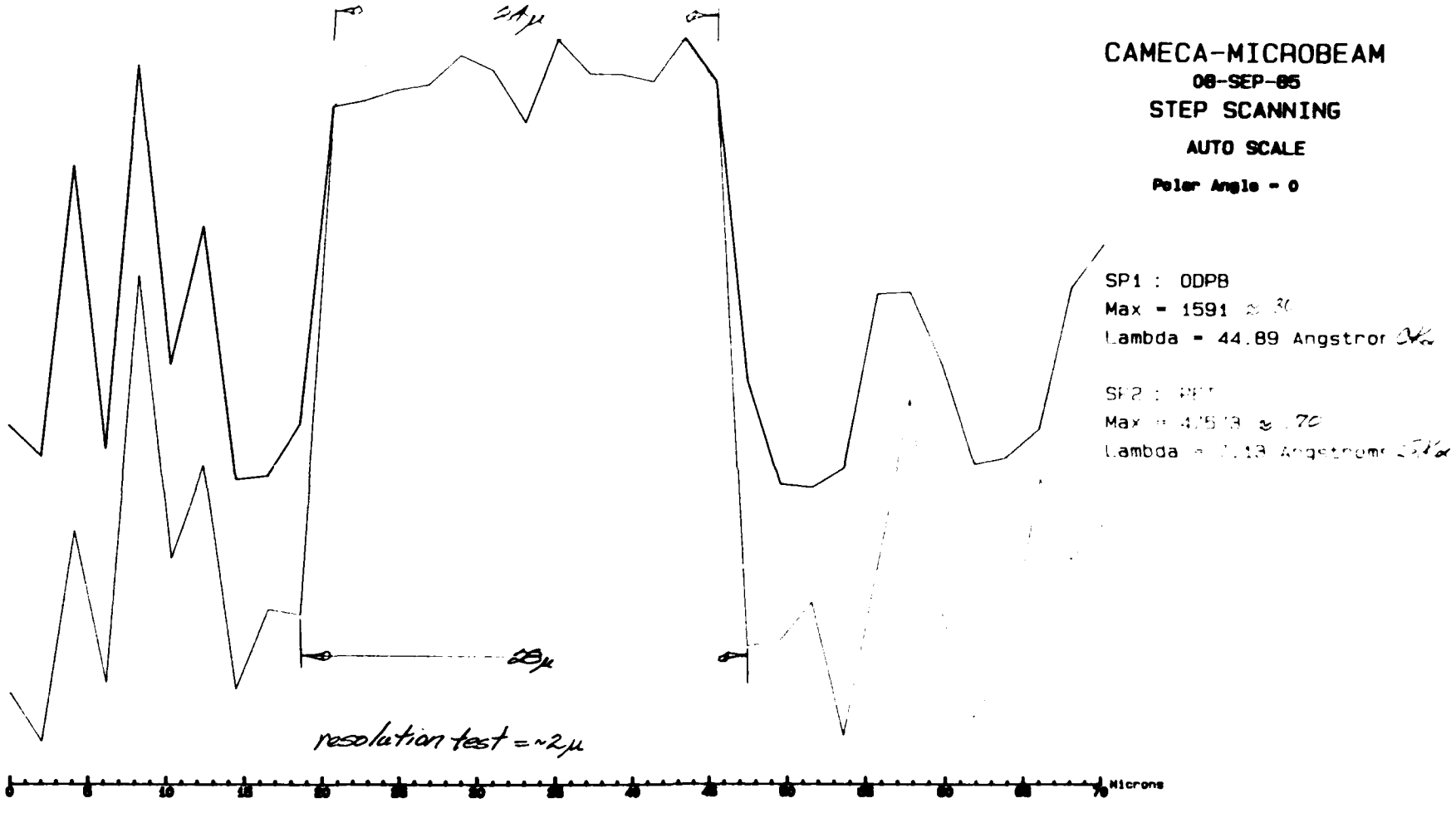
This report describes characterization tests performed on low-pressure plasma processed precomposited powders. Powder preparation and plasma processing parameters were described in a previous report. In particular we describe the microchemical characterization performed on two types of low-pressure plasma processed precomposited powders which were allowed to solidify in free flight and this did not impinge upon the water-cooled substrate, i. e. were not incorporated into a deposit, and compare the results to the starting precomposited powders. Microstructural features of these materials were also described in a previous report. The two types of precomposited powders used for these experiments were 1100 aluminum - 30 wt.% SiC_p and aluminum - 5 wt.% Ti - 30 wt.% SiC_p .

Figure 1 shows the C and Si microprobe traces across a representive large SiC particle in the microstructure of the as-produced 1100 - 30 wt.% SiC_p precomposited powder. The SiC particle showed edge X-ray resolution of 2 microns which is approximately equal to the theoretical resolution at the 15 KV beam voltage used. Corrected X-ray intensity ratios for Si and C are 30:1 for the as-produced material which is assumed to contain stoichiometric silicon carbide. For comparison, Figure 2 shows the microprobe traces obtained for low

pressure plasma-processed 1100 - 30 wt.% SiC_p precomposited powders. The most striking feature of the microstructure of the plasma-processed powder is the significant reduction in the number of large SiC particles present in the microstructure. A backscattered electron image showing the microprobe trace is shown in Figure 3. The majority of SiC particles in the microstructure were found to be less than 5 microns in diameter which is nearly a factor of three smaller than in the as-produced powders. As shown in Figure 3, the microprobe trace passes through two of the small SiC particulates. The peak X-ray intensities for Si and C are reduced to a ratio of 20.4 suggesting possible loss of Si due to vaporization, however the small SiC particle size may affect this result since the SiC particle size now is only twice the theoretical resolution limit. The resolution does not permit inference as to possible increases in C concentration at the particle/matrix interface caused by plasma processing (compare C profiles in Figure 2 to those in Figure 1). Such increases in C concentration might suggest the presence of Al_4C_3 at the particle/matrix interface. The shape of the Si profile near the interface does suggest possible Si dissolution into the matrix as would be expected if Al_4C_3 is formed at the interface, however.

Figure 4 shows the microprobe traces for the as-produced aluminum - 5 wt.% titanium - 30 wt.% SiC_p powders. Figure 5 shows a backscattered electron image of the microstructure corresponding to the microprobe trace in Figure 4. The microprobe trace shown in Figure 4 indicates a loss of edge resolution for the SiC particulates (to about 4 microns) suggesting that some Ti/SiC reaction may have occurred during low-temperature processing, although this seems highly unlikely. The Si:C peak X-ray intensity ratio is only 13.5 and the C and Si peak intensities are slightly displaced. Both of these observations are

believed to be artifacts of the measurement techniques used. The titanium concentration curves indicate the presence of fine Ti-rich phase particles in the matrix phase as noted previously in metallographic examination. Figure 6 shows the microprobe traces for the low-pressure plasma processed aluminum - 5 wt.% titanium - 30 wt.% SiC_p powders. The corresponding backscattered electron micrograph is shown in Figure 7. As above, a reduction in average SiC particle size is noted after plasma processing. The SiC peak X-ray intensity ratio is now measured at 24.4 which is in reasonable agreement with the measurements on the plasma processed 1100 - 30 wt.% SiC_p powders. The titanium concentration shows an apparent buildup in the near-interfacial matrix phase suggesting some interfacial TiC formation and does not show the "peaking" in one matrix away from the interface which would be expected if Ti-rich intermetallics were present. A high Ti concentration may possibly have been "quenched in" to form a non-equilibrium microstructure devoid of the Al_3Ti phase. No clear evidence of the expected interfacial TiC formation is found, but again the resolution is too low to observe this interfacial phase directly. Similar analyses of composite deposits produced on water-cooled substrates are in progress.



#1 starting Powder; 1100+30% SiC; CKα; SiKα; 15Kv; 10 nA; 110 photo

Figure 1.

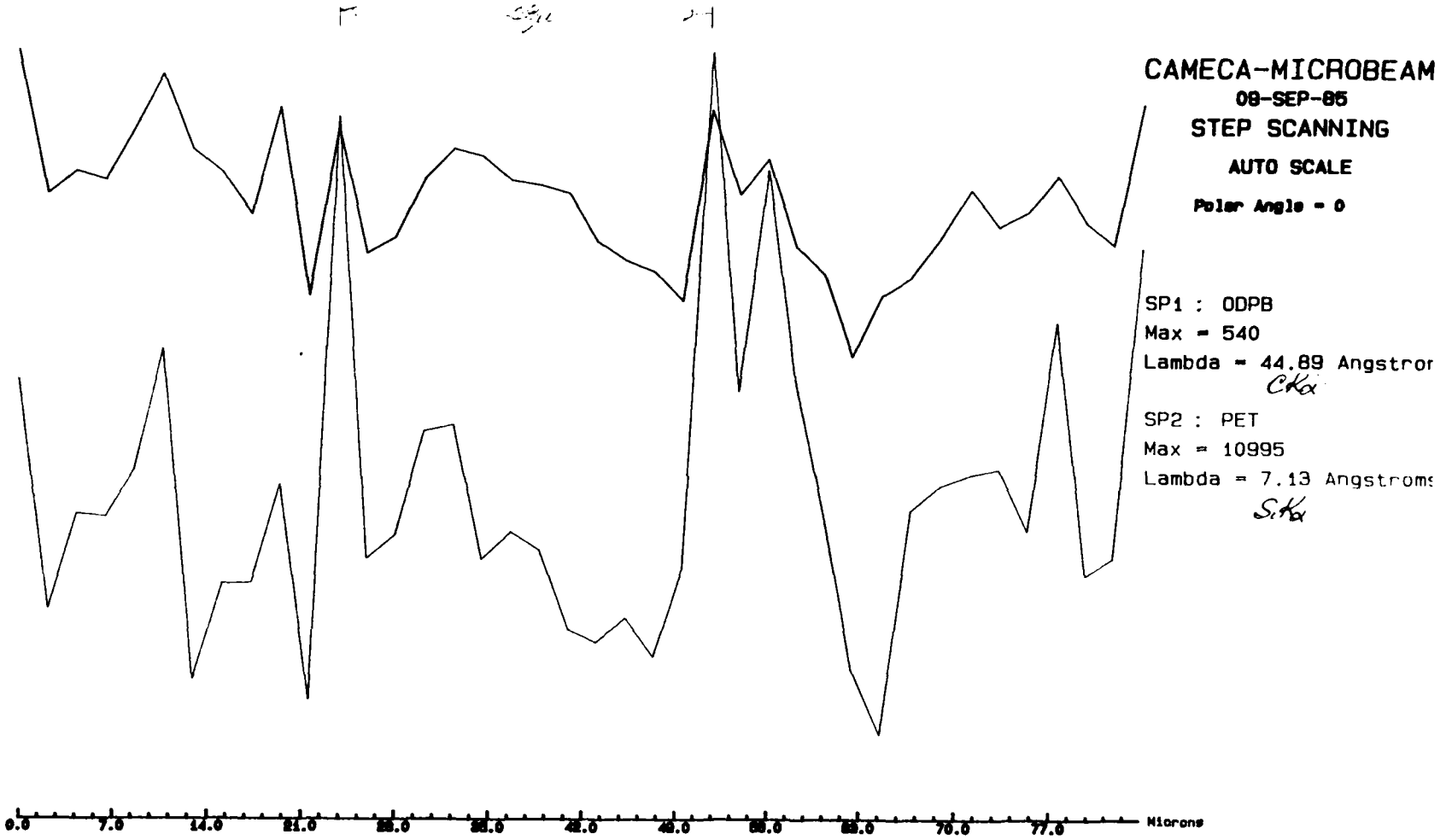


Figure 2.

#3 final Powder 1100 +30% SiC ; CKα + SiKα ; 15 kV ; 2.3 nA on P ; Backscattered electron image Mag = 2000x

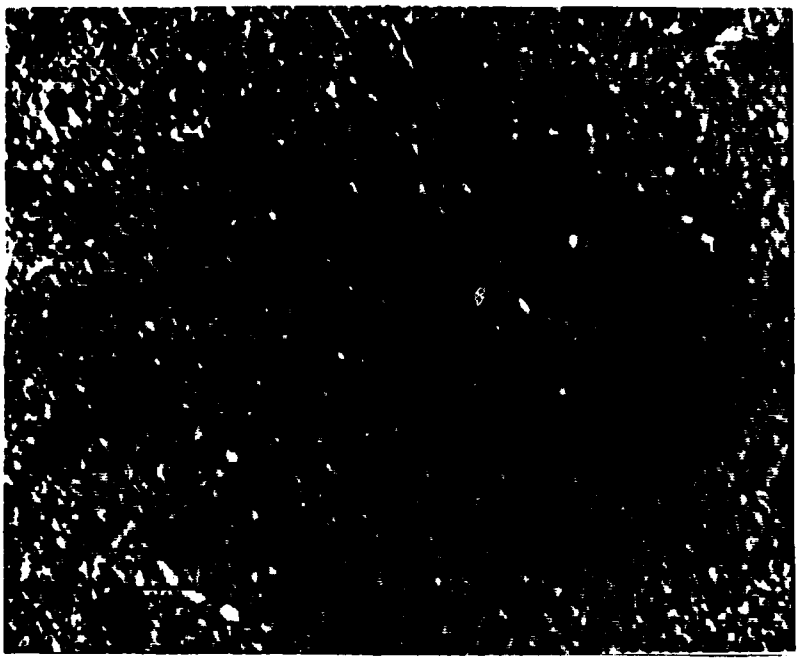


Figure 3. Backscattered electron image showing the path of the microprobe trace presented in Figure 2.

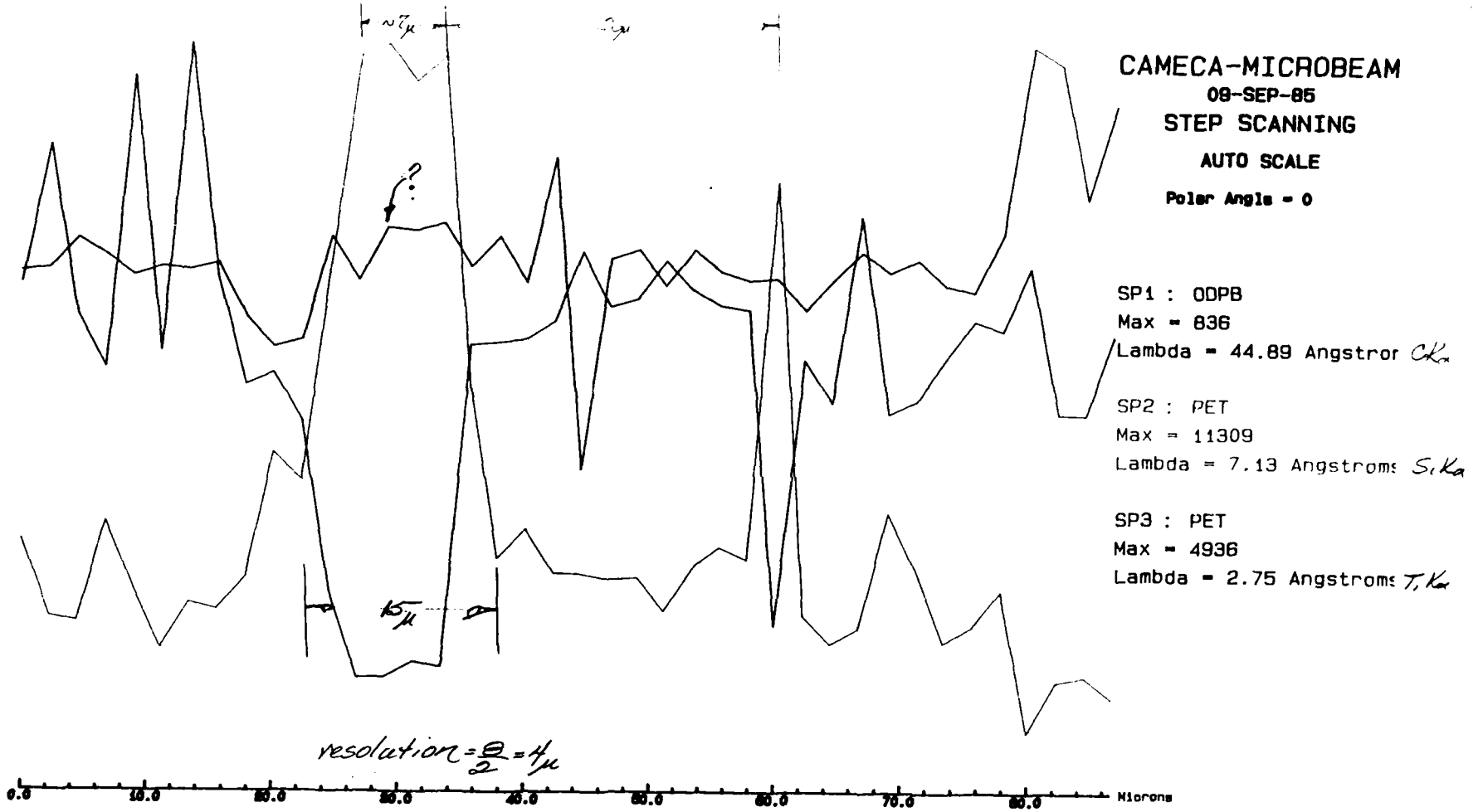


Figure 4.

#1 Starting powder; Al 5Ti + 30% SiC; CKα; SiKα; TiKα; 15Kv; 2.41nanoA; Backscattered electron; mag = 1500X

Figure 5. Backscattered electron image showing the path of the microprobe trace presented in Figure 4.

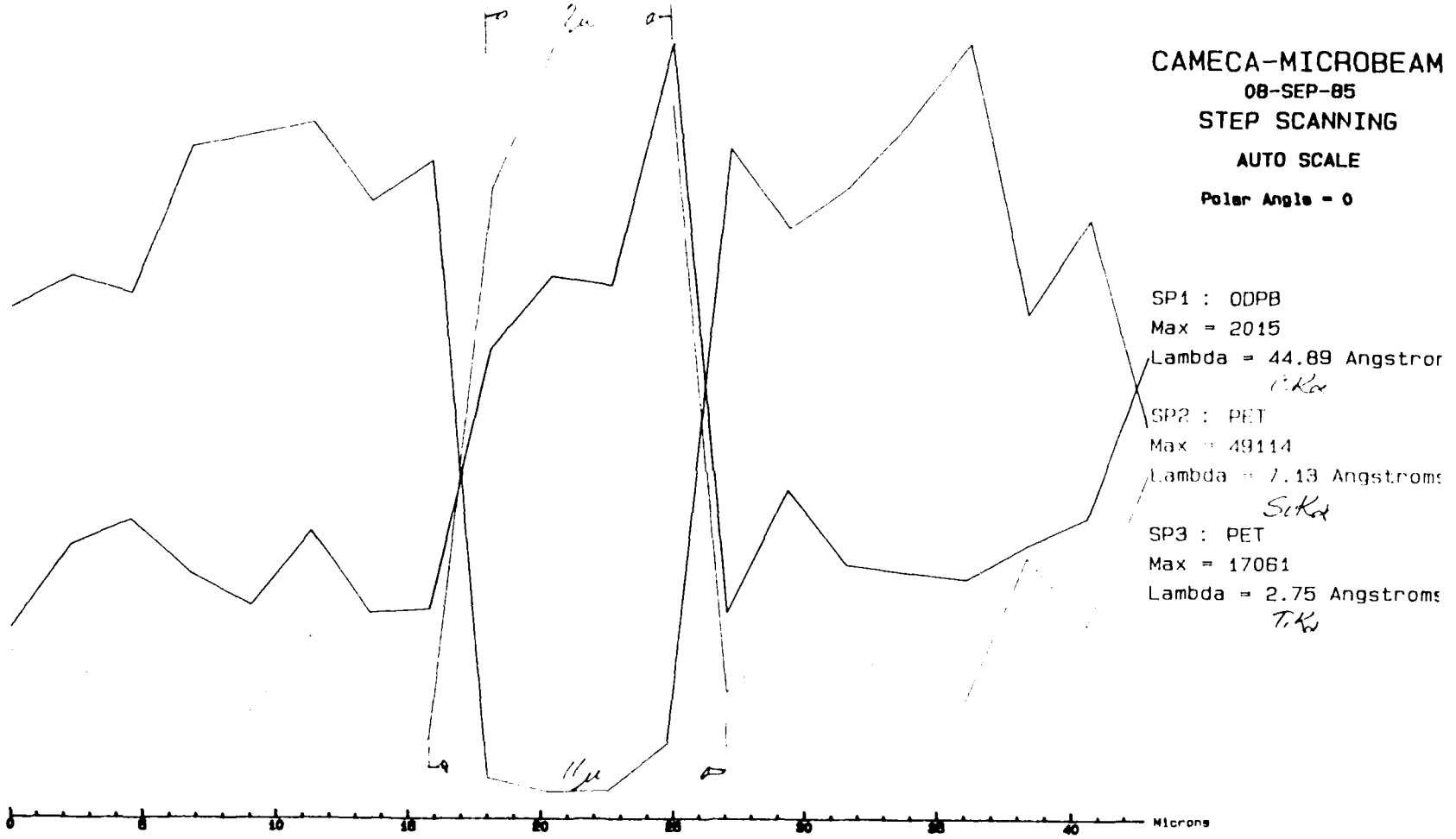


Figure 6.

#3 Final Powder [illegible]

Figure 7. Backscattered electron image showing the path of the microprobe trace presented in Figure 6.

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